PATENT SPECIFICATION

DRAWINGS ATTACHED

1,124,564

1,124,564

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COMPLETE SPECIFICATION

Improvements in or relating to Sub-Assemblies consisting of Electrical Components Embedded in a Block of Plastics Material

We, SIEMENS AKTIENGESELLSCHAFT, formerly Siemens & Halske Aktiengesellschaft, a German Company of Berlin and Munich, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to sub-assemblies consisting of electrical components and/or functional electric circuits embedded in a block of synthetic plastics material. The electrical components referred to are preferably those provided with terminal wires and may be, for example, resistors, capacitors, transistors, diodes and the like. All these components have at least two terminal wires. Components having more than three connecting wires, for example, magnetic cores with several windings, and functional electric circuits, such as thin-film circuits deposited on substrates, the external connections of which are constituted by connecting wires, may also be included in a sub-assembly according to the invention. Throughout this description of the invention the term "functional electric circuit" is used to denote any assembly of two or more connected active and/or passive electrical components.

The electrical components and/or functional electric circuits are so arranged within the block of plastics material, that their connecting wires terminate in at least one lateral surface of the block and are therein connected to each other and/or to external contact pins by means of printed conductor strips according to a desired wiring diagram.

Sub-assemblies of this kind, to which the present invention relates, and methods of producing them, have been described, for example, in Patent Specification 1,002,237. In order to simplify the connecting-up of the individual electrical components with each other and/or with the external contact pins, the components and their terminal wires are usually arranged in the block of plastics material so that the connecting wires or the contacting ends of the contact pins terminate on at least one lateral surface of the plastics block in a standardised pattern. By appropriate distribution of the individual components within the plastics block, it has been possible to realise a large proportion of the desired wiring diagrams by using a conductor system deposited in a single layer only on each circuit face of the block.

However, if the packing density of the components in the plastics block becomes very high, then the placing of the individual elements may have to depend not only upon the desired circuit diagram, but also upon the positional relationship of the components determined by their size. Then it may happen that the individual conductor strips have to cross each other.

Figure 1 of the accompanying drawing schematically illustrates such a desired circuit. The points 1 to 12 are contact points, at which connecting wires of components and/or functional electric circuits terminate on the surface 13 of the plastics block 14. To realise the desired circuit diagram, the contact points 1 and 5, 5 and 6, 3 and 7, 4 and 8, 7 and 11, as well as 10 and 11, are to be interconnected. In addition, connections have to be made between the points 2 and 8 and the points 9 and 12. The line extending between the points 2 and 8 must cross the conductor strip extending between the points 3 and 7, and the conductor extending between

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the points 9 and 12 must cross the conductor strip extending between the points 7 and 11.

Such cases of intersecting conductor strips are known in printed circuit technology, but the procedure of producing first the printed circuit with the line inter-sections and branchings, and mounting the components thereafter on the printed circuit, cannot be applied to sub-assemblies of the kind to which the present invention relates.

Multi-layer circuits have already been used with sub-assemblies of this kind, but not on the lateral faces of the plastics block in which the connecting wires of the components terminate. A socket was provided separate from the sub-assembly and consisting of a base plate with contact pins projecting therefrom, serving to fit the sub-assembly into a printed-circuit plate. This socket was joined to the sub-assembly, for example, by cementing it to the lateral surface of the plastics block on which the connecting wires coming from components terminated, said connecting wires being joined by only single-layer conductor strips. Prior to the mounting of the socket, the sub-assembly was not completely connected up and the socket or its individual contact pins were employed for this purpose, by slipping on to the pins several plates bearing printed conductor strips corresponding to the rest of the required circuit. This method is complicated and time-consuming and has the drawback that the wiring of the sub-assembly is complete only after the socket has been mounted. Connections have been produced on the lateral surface of a plastics block, in which connecting wires terminate, by covering the whole surface with a chemically-deposited copper layer strengthened by electroplating, the conductor pattern then being formed from this layer by known etching processes.

The object of the present invention is to solve the problems already described and to produce complex circuits in a simple and rapid manner.

The invention accordingly consists in a method of producing external connections on a sub-assembly comprising electrical components and/or functional electric circuits embedded in a block of plastics material and having connecting wires terminating in connection points at at least one lateral surface of said block, wherein first flat connecting conductor strips are produced on said surface to interconnect said connection points in a predetermined manner, said first conductor strips then being covered by one or more insulating layers each carrying further flat connecting conductor strips, conductive connections between one or more of said further conductor strips and one or more of said connection points being thereafter produced by making bores in the insulating layers and chemically metallising and/or electroplating the surface produced by said bores.

By this means, connections can be provided on a lateral face of the plastics block in at least two planes.

The conductor strips of the first plane at least preferably consist of chemically-deposited copper strengthened by electroplating. The material used for the insulating layer may be a hardenable lacquer suitable for screen printing, e.g. an alkyd resin lacquer, the surface of which is roughened by the inclusion thereinto of solid particles which are insoluble in said lacquer.

Although printed conductor strips can be deposited on a lacquer not incorporating solid particles, there is the danger in this case that the conductor strips may be wiped off accidentally. The surface of the lacquer can of course be also roughened by treatment with a sandblaster or the like.

The invention also consists in a sub-assembly comprising electrical components and/or functional electric circuits embedded in a block of plastics material and having connecting wires terminating in connection points at at least one lateral surface of said block when produced by the method of the invention.

Our co-pending Application No: 24818/66 (Serial No. 1124376) describes similar sub-assemblies which however are produced by a different method.

The invention will now be more particularly described with reference to the Figures of the accompanying drawing, in which:—

Figure 1 shows a schematic of a desired circuit diagram; and

Figure 2 shows a section along the line II—II of Figure 1 through an example of a sub-assembly according to the invention.

In Figure 2, the plastics block 14 accommodates components 15, the connecting wires 16 of which terminate in the lateral surface 13 of the plastics block. The lateral surface 13 is produced by abrasion, after the plastics block has been formed in a mould. The section of Figure 2 passes through the contact points 9, 10, 11 and 12 of Figure 1. On these contact points metal spots 19, 20, 21 and 22 have been deposited and between the contact surfaces 20 and 21 there extends a conductor strip of the first plane. On this first plane an insulating layer 17 has been deposited, which in the first instance covers the metal spots and the conductor strips as well as the metal-free portions of the lateral surface 13. Thereafter, at the desired positions, namely at the contact points 9 and 12, conically extending bores 23 and 24 have been produced. The bore 23 extends into the contact wire 16, in order to increase the contact surface. However, when more layers are present, it is advisable not to bore too deeply, so that the bore 24 is shown as

extending only into the metal spot 22. The bores 23 and 24 are then provided in a known manner, by chemical metallising and/or electroplating, with metal layers 25 and 26 respectively. It is better to produce the conductor strip 27 simultaneously with this metallising step, but it is also possible to produce the conductor strip prior to making the bores.

The making of these bores does not present any problem, because the contact points are distributed according to a predetermined pattern, so that the boring or milling implements can be arranged according to this pattern to engage at the contact points with great precision.

WHAT WE CLAIM IS:—

1. A method of producing external connections on a sub-assembly comprising electrical components and/or functional electric circuits embedded in a block of plastics material and having connecting wires terminating in connection points at at least one lateral surface of said block, wherein first flat connecting conductor strips are produced on said surface to interconnect said connection points in a predetermined manner, said first conductor strips then being covered by one or more insulating layers each carrying further flat connecting conductor strips, conductive connections between one or more of said further conductor strips and one or more of said connection points being thereafter produced by making bores in the insulating layers and chemically metallising and/or electroplating the surface produced by said bores.

2. A method as claimed in Claim 1, wherein at least said first conductor strips are produced by the chemical deposition of copper which is thereafter strengthened by electroplating.

3. A method as claimed in Claim 1 or Claim 2, wherein said insulating layer or layers consist of a hardenable lacquer, the surface of which is rough due to the inclusion of solid particles, insoluble therein, in the lacquer.

4. A method as claimed in Claim 3, wherein said hardenable lacquer is an alkyd resin suitable for screen printing.

5. A sub-assembly comprising electrical components and/or functional electric circuits embedded in a block of plastics material and having connecting wires terminating in connection points at at least one lateral surface of said block, produced by the method claimed in any one of Claims 1 to 4.

6. A sub-assembly as claimed in Claim 5, substantially as herein described with reference to and as illustrated in the Figures of the accompanying drawing.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

Fig.1

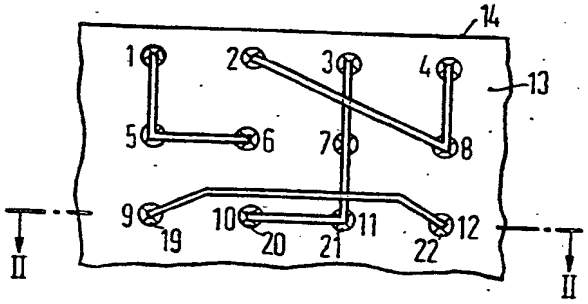

Fig.2